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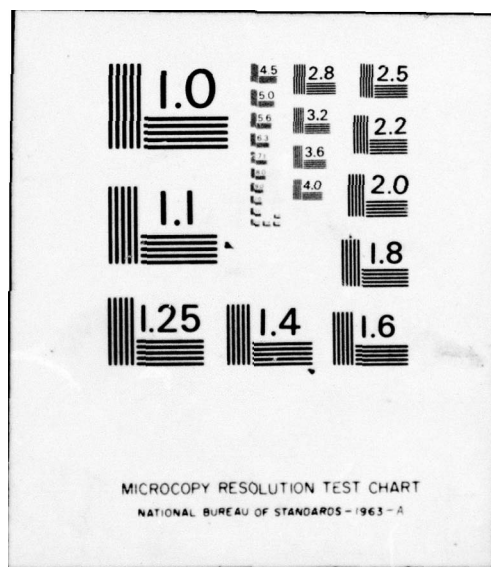                SEP 74    B C EAVES                                         DAHC04-71-C-0041
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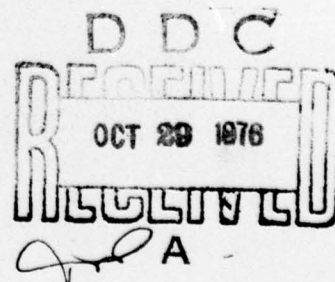MATHEMATICAL PROGRAMS

FINAL REPORT

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B. Curtis Eaves
Principal Investigator

September 13, 1974

U. S. ARMY RESEARCH OFFICE

CONTRACT: DAHC-04-71-C-0041

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**13. ABSTRACT**

The research supported under this contract has led, in conjunction
with results of others, to a general new tool for solving
systems of equations (e.g., differential equations).

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The research conducted under ARO Contract DAHC-04-71-C-0041,
which covered the period 25 June 1971 to 24 June 1974, is contained
in the Reports [1] to [14].

The fundamental finding of this research is, in conjunction with
that of others, a general new tool for solving systems of equations
(hence differential equations, for example). This principle which
was first described in [2] and [4] can be described as follows: To
solve the given problem $f_1(x) = y$ one first deforms $f_1$ to $f_0$
where $f_0$ is of similar dimension and structure of $f_1$ and where
$f_0(x) = y$ has a unique trivial solution $x_0$. Then deforming $f_0$
back to $f_1$, perhaps with regressions, one follows the solution $x$ of
$f_t(x) = y$ to obtain a solution to the given problem $f_1(x) = y$. This
technique is distinct from classical methods of continuation in that the
scheme can in a non cyclic, systematic way retrogress; as a consequence,
a more difficult system of equations can be solved.

Given two to five more years of development this new technique will
be a major force in solving large and difficult systems of equations.
Already, more difficult problems are being modeled and solved (see the
report [12], for example).

The reports [1, 3, 5, 6, 7, 8, 11, 13, 14] contributed to or extend
the deformation principle described above.

1. "Computing Kakutani Fixed Points," <u>SIAM J. Appl. Math</u>., 21, 2, September 1971, 236-244.

2. "On the Basic Theorem of Complementarity," <u>Math. Prog.</u>, 1, 1, October 1971, 68-75.

3. "Piecewise Linear Retractions by Reflexion," <u>Linear Algebra and its Applications,</u> 7, 1973, 93-98.

4. "Homotopies for Computation of Fixed Points," <u>Math. Prog.</u>, 1, 3, August 1972, 1-22.

5. "Homotopies for Computation of Fixed Points on Unbounded Regions," <u>Math. Prog.</u>, 3, 2, October 1972, 225-237.

6. "Polymatrix Games with Joint Constraints," <u>SIAM J. Appl. Math</u>., 24, 3, May 1973, 418-423.

7. "Fourier-Motzkin Elimination and its Dual," with G. B. Dantzig, <u>Journ. of Comb. Theory</u>, 14, 3, May 1973, 288-297.

8. "A Fixed Point Theorem from Dynamic Programming," Department of Operations Research, Stanford University, January 1973. Will appear as "Complementary Pivot Theory and Markovian Decision Choice"in <u>Fixed Points: Algorithm and Application</u>, 1975, Academic Press, Editor: Stepan Karamardian.

9. "An Algorithm for the Optimal Policy and Maximum Probability of Choosing the Best or Second-Best from a Sequence of Independent Values," Stanford University, February 1972.

10. "Optimal Choosing Problems," Willis to Rasmussen, Department of Operations Research, Stanford University, December 1972.

11. "Properly Labeled Simplexes," to appear in <u>Studies in Optimization</u>, 1974, Math. Assn. of America, Editors: G. B. Dantzig and B. C. Eaves.

12. "The Computations of Fixed Points," Richard J. Wilmuth, Department of Operations Research, Stanford University, July 1973.

13. "Solving Piecewise Linear Convex Equations," to appear in Vol. 1 <u>of Math. Prog. Studies.</u>

14. "On the Need for a System Optimization Laboratory," with G. B. Dantzig, R. W. Cottle, F. S. Hillier, A. S. Mann, G. H. Golub, D. J. Wilde, R. B. Wilson, <u>Math. Prog.</u>, Academic Press, 1973, 1-32.